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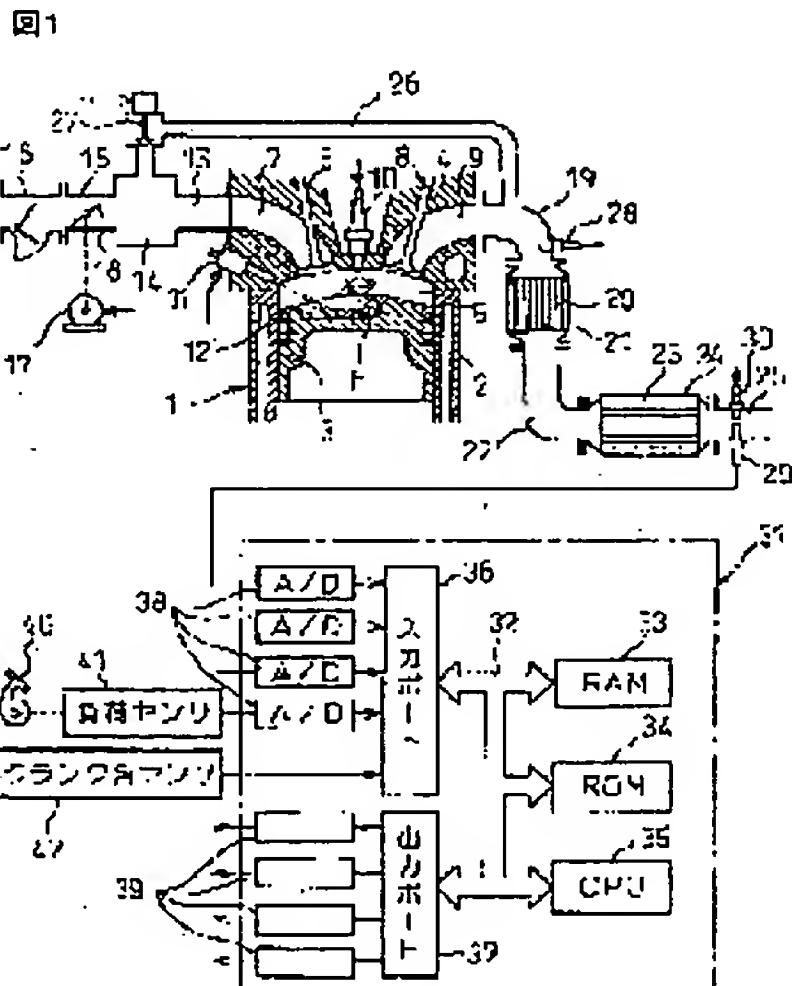
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## (54) APPARATUS FOR DETECTING ABNORMALITY OF NOx SENSOR

(57) Abstract:

PROBLEM TO BE SOLVED: To provide an apparatus for detecting the abnormality of an NOx sensor.

SOLUTION: The apparatus for detecting the abnormality of an NOx sensor is for detecting any abnormality of an NOx sensor which outputs a different value depending on the NOx concentration of exhaust gas emitted from a combustion chamber of an internal combustion engine and which can detect the NOx concentration of the gas based on the output value. The apparatus forcibly varies the NOx concentration of the gas reaching the NOx sensor, and determines the NOx sensor to have an abnormality if a variation of the value outputted by the NOx sensor is out of the range of variations which will occur if the NOx sensor is under normal conditions.



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**CLAIMS****[Claim(s)]**

[Claim 1] The output value of a value which is different according to the NOx concentration in the exhaust gas discharged from an internal combustion engine's combustion chamber is outputted. In the NOx sensor malfunction detection equipment for detecting the abnormalities of a NOx sensor which can detect the NOx concentration in exhaust gas from this output value The NOx concentration in the exhaust gas which reaches a NOx sensor is fluctuated compulsorily. NOx sensor malfunction detection equipment characterized by making it judge with abnormalities being in a NOx sensor when having shifted from the fluctuation which can be taken when the NOx sensor concerned has normal fluctuation of the output value which a NOx sensor outputs at this time.

[Claim 2] NOx sensor malfunction detection equipment according to claim 1 characterized by making it fluctuate the NOx concentration in exhaust gas compulsorily more greatly than fluctuation of the NOx concentration in the exhaust gas which can be taken when the internal combustion engine is made to operate according to the usual operation control.

[Claim 3] NOx sensor malfunction detection equipment according to claim 1 characterized by making it fluctuate the NOx concentration in exhaust gas compulsorily by fluctuating compulsorily the amount of the exhaust gas made to circulate by the combustion chamber when it is constituted so that an internal combustion engine may make a combustion chamber circulate through the exhaust gas discharged from the combustion chamber again.

[Claim 4] NOx sensor malfunction detection equipment according to claim 1 characterized by making it fluctuate the NOx concentration in exhaust gas compulsorily by fluctuating compulsorily the temperature of the exhaust gas made to circulate by the combustion chamber when it is constituted so that an internal combustion engine may make a combustion chamber circulate through the exhaust gas discharged from the combustion chamber again.

[Claim 5] NOx sensor malfunction detection equipment according to claim 1 characterized by making it fluctuate the NOx concentration in exhaust gas compulsorily by fluctuating compulsorily the timing which lights a fuel in a combustion chamber.

[Claim 6] NOx sensor malfunction detection equipment of any one publication of claim 1-5 characterized by performing control for detecting the abnormalities of a NOx sensor only when a steady state has operation of an internal combustion engine.

[Claim 7] NOx which will be absorbed if the air-fuel ratio in the exhaust gas which absorbs NOx in exhaust gas and flows becomes rich when the air-fuel ratio of the flowing exhaust gas is Lean is emitted. With the hydrocarbon in exhaust gas The NOx absorbent which will generate ammonia if the amount of NOx which carries out reduction clarification, and is absorbed while the air-fuel ratio of the flowing exhaust gas is rich approaches zero is arranged in an internal combustion engine's flueway. When being arranged in the flueway of a NOx absorbent lower stream of a river so that the NOx concentration in the exhaust gas with which the above-mentioned NOx sensor flows out of this NOx absorbent may be detected NOx sensor malfunction detection equipment of any one publication of claim 1-5 characterized by detecting the abnormalities of a NOx sensor when the air-fuel ratio of the exhaust gas which flows into a NOx absorbent is Lean.

[Claim 8] The output value of a value which is different according to the NOx concentration in the exhaust gas discharged from an internal combustion engine's combustion chamber is outputted. In the NOx sensor malfunction detection equipment for detecting the abnormalities of a NOx sensor

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which can detect the NOx concentration in exhaust gas from this output value NOx which will be absorbed if the air-fuel ratio of the exhaust gas which absorbs NOx in exhaust gas and flows becomes rich when the air-fuel ratio of the flowing exhaust gas is Lean is emitted. With the hydrocarbon in exhaust gas The NOx absorbent which will generate ammonia if the amount of NOx which carries out reduction clarification, and is absorbed while the air-fuel ratio of the flowing exhaust gas is rich approaches zero is arranged in an internal combustion engine's flueway. The output value of the value from which the above-mentioned NOx sensor differs according to the ammonia concentration in exhaust gas is outputted. When being arranged in the flueway of a NOx absorbent lower stream of a river so that the NOx concentration or ammonia concentration in the exhaust gas with which the ammonia concentration in exhaust gas can be detected from this output value, and the above-mentioned NOx sensor flows out of this NOx absorbent may be detected The amount of NOx which supplies the exhaust gas of a rich air-fuel ratio to a NOx absorbent, and is absorbed by the NOx absorbent is brought close to zero. NOx sensor malfunction detection equipment characterized by judging with abnormalities being in a NOx sensor when having shifted from the fluctuation which can be taken when the NOx sensor concerned has normal fluctuation of the output value which a NOx sensor outputs at this time.

[Translation done.]

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## DETAILED DESCRIPTION

## [Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to NOx sensor malfunction detection equipment.

[0002]

[Description of the Prior Art] The NOx sensor for detecting the NOx concentration in the exhaust gas discharged by the internal combustion engine is indicated by JP,11-14589,A. moreover, in order to know whether the NOx concentration detected by the NOx sensor is exact Although a pump current generates oxygen in inter-electrode [ for carrying out pumping processing / two ] in this way in the above-mentioned official report when pumping processing of the oxygen in exhaust gas is carried out in order to detect NOx concentration since it is necessary to detect the abnormalities of a NOx sensor If the NOx sensor is normal when the circuit containing an electrode is heated at a heater, he is trying for an impedance inter-electrode [ these ] to detect the abnormalities of a NOx sensor using becoming a certain fixed value.

[0003] That is, when the circuit containing the electrode for carrying out pumping processing of the oxygen is heated at a heater and the impedance inter-electrode [ these ] has not reached default value, he is trying to judge with abnormalities being in a NOx sensor in the above-mentioned official report.

[0004]

[Problem(s) to be Solved by the Invention] Thus, there is a request of detecting the abnormalities of a NOx sensor, in the field of a NOx sensor. Then, the object of this invention is to offer the NOx sensor malfunction detection equipment which adopted a different approach from the NOx sensor malfunction detection approach indicated by the above-mentioned official report.

[0005]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem in the 1st invention The output value of a value which is different according to the NOx concentration in the exhaust gas discharged from an internal combustion engine's combustion chamber is outputted. In the NOx sensor malfunction detection equipment for detecting the abnormalities of a NOx sensor which can detect the NOx concentration in exhaust gas from this output value The NOx concentration in the exhaust gas which reaches a NOx sensor is fluctuated compulsorily, and when having shifted from the fluctuation which can be taken when the NOx sensor concerned has normal fluctuation of the output value which a NOx sensor outputs at this time, it judges with abnormalities being in a NOx sensor. Namely, since a NOx sensor outputs the output value of a different value according to the NOx concentration in exhaust gas If the NOx concentration in exhaust gas is fluctuated compulsorily, the output value of a NOx sensor will also be changed. If the NOx sensor is normal here, since it should change that the output value of a NOx sensor is also at a certain predetermined gestalt at this time If it has shifted from the fluctuation which can be taken when a NOx sensor has normal fluctuation of the output value of the NOx sensor at this time, abnormalities have arisen in the NOx sensor.

[0006] In the 2nd invention, the NOx concentration in exhaust gas is compulsorily fluctuated in the 1st invention more greatly than fluctuation of the NOx concentration in the exhaust gas which can be taken when the internal combustion engine is made to operate according to the usual operation control.

[0007] When it consists of the 3rd invention so that an internal combustion engine may make a combustion chamber circulate through the exhaust gas discharged from the combustion chamber again in the 1st invention, the NOx concentration in exhaust gas is compulsorily fluctuated by fluctuating compulsorily the amount of the exhaust gas made to circulate by the combustion chamber.

[0008] When it consists of the 4th invention so that an internal combustion engine may make a combustion chamber circulate through the exhaust gas discharged from the combustion chamber again in the 1st invention, the NOx concentration in exhaust gas is compulsorily fluctuated by fluctuating compulsorily the temperature of the exhaust gas made to circulate by the combustion chamber.

[0009] In the 5th invention, the NOx concentration in exhaust gas is compulsorily fluctuated in the 1st invention by fluctuating compulsorily the timing which lights a fuel in a combustion chamber.

[0010] In the 6th invention, in the 1-5th invention, only when a steady state has operation of an internal combustion engine, control for detecting the abnormalities of a NOx sensor is performed.

[0011] In the 7th invention, it sets to the 1-5th invention. NOx which will be absorbed if the air-fuel ratio in the exhaust gas which absorbs NOx in exhaust gas and flows becomes rich when the air-fuel ratio of the flowing exhaust gas is Lean is emitted. With the hydrocarbon in exhaust gas The NOx absorbent which will generate ammonia if the amount of NOx which carries out reduction clarification, and is absorbed while the air-fuel ratio of the flowing exhaust gas is rich approaches zero is arranged in an internal combustion engine's flueway. When being arranged in the flueway of a NOx absorbent lower stream of a river so that the NOx concentration in the exhaust gas with which the above-mentioned NOx sensor flows out of this NOx absorbent may be detected, and the air-fuel ratio of the exhaust gas which flows into a NOx absorbent is Lean, the abnormalities of a NOx sensor are detected.

[0012] In order to solve the above-mentioned technical problem in the 8th invention The output value of a value which is different according to the NOx concentration in the exhaust gas discharged from an internal combustion engine's combustion chamber is outputted. In the NOx sensor malfunction detection equipment for detecting the abnormalities of a NOx sensor which can detect the NOx concentration in exhaust gas from this output value NOx which will be absorbed if the air-fuel ratio of the exhaust gas which absorbs NOx in exhaust gas and flows becomes rich when the air-fuel ratio of the flowing exhaust gas is Lean is emitted. With the hydrocarbon in exhaust gas The NOx absorbent which will generate ammonia if the amount of NOx which carries out reduction clarification, and is absorbed while the air-fuel ratio of the flowing exhaust gas is rich approaches zero is arranged in an internal combustion engine's flueway. The output value of the value from which the above-mentioned NOx sensor differs according to the ammonia concentration in exhaust gas is outputted. When being arranged in the flueway of a NOx absorbent lower stream of a river so that the NOx concentration or ammonia concentration in the exhaust gas with which the ammonia concentration in exhaust gas can be detected from this output value, and the above-mentioned NOx sensor flows out of this NOx absorbent may be detected The amount of NOx which supplies the exhaust gas of a rich air-fuel ratio to a NOx absorbent, and is absorbed by the NOx absorbent is brought close to zero. When having shifted from the fluctuation which can be taken when the NOx sensor concerned has normal fluctuation of the output value which a NOx sensor outputs at this time, it judges with abnormalities being in a NOx sensor. Namely, since a NOx sensor outputs the output value of a different value according to the ammonia concentration in exhaust gas If the amount of NOx which supplies the exhaust gas of a rich air-fuel ratio to a NOx absorbent, and is absorbed by the NOx absorbent is brought close to zero Ammonia flows out of a NOx absorbent, therefore the output value of a NOx sensor is also changed. If the NOx sensor is normal here, since it should change that the output value of a NOx sensor is also at a certain predetermined gestalt at this time If it has shifted from the fluctuation which can be taken when a NOx sensor has normal fluctuation of the output value of the NOx sensor at this time, abnormalities have arisen in the NOx sensor.

[0013]

[Embodiment of the Invention] The example of this invention is explained with reference to a drawing. Although the example which applied this invention to the cylinder-injection-of-fuel type spark-ignition engine is explained below, this invention is applicable also to a compression ignition

type internal combustion engine.

[0014] When drawing 1 is referred to, in an inlet valve and 7, an inlet port and 8 show an exhaust valve and 9 shows [ the piston at which in 1 an engine body and 2 reciprocate with a cylinder block, and 3 reciprocates within a cylinder block 2, the cylinder head by which 4 was fixed on the cylinder block 2, the combustion chamber where 5 was formed between a piston 3 and the cylinder head 4, and 6 ] an exhaust port, respectively. As shown in drawing 1 , an ignition plug 10 is arranged in the center section of the internal surface of the cylinder head 4, and a fuel injection valve 11 is arranged at the internal-surface periphery of the cylinder head 4. Moreover, on the top face of a piston 3, the cavity 12 prolonged from the lower part of a fuel injection valve 11 to the lower part of an ignition plug 10 is formed.

[0015] The inlet port 7 of each cylinder is connected with a surge tank 14 through the inhalation-of-air branch pipe 13 which corresponds, respectively, and a surge tank 14 is connected with an air cleaner (not shown) through an air intake duct 15 and an air flow meter 16. In an air intake duct 15, the throttle valve 18 driven with a step motor 17 is arranged. On the other hand, this exhaust manifold 19 minds the catalytic converter 21 and exhaust pipe 22 which contained the oxidation catalyst or the three way component catalyst 20 by connecting with an exhaust manifold 19, and the exhaust port 9 of each cylinder is NOX. It connects with the casing 24 which built in the absorbent 23. an exhaust manifold 19 and a surge tank 14 -- recirculation exhaust gas (henceforth EGR gas) -- it connects mutually through a conduit 26 -- having -- this EGR gas -- the EGR gas control valve 27 is arranged in a conduit 26.

[0016] An electronic control unit 31 consists of a digital computer, and RAM (random access memory)33, ROM (read-only memory)34, CPU (microprocessor)35, the input port 36, and the output port 37 which were mutually connected through the bidirectional bus 32 are provided. An air flow meter 16 generates the output voltage proportional to an inhalation air content, and is inputted into input port 36 through A-D converter 38 to which this output voltage corresponds. The air-fuel ratio sensor 28 for detecting an air-fuel ratio to an exhaust manifold 19 is attached, and it is inputted into input port 36 through A-D converter 38 to which the output signal of this air-fuel ratio sensor 28 corresponds. Moreover, NOX In the exhaust pipe 25 connected to the outlet of the casing 24 which built in the absorbent 23, it is NOX in exhaust gas. The NOX sensor 29 which can detect concentration, and the air-fuel ratio sensor 30 which can detect an air-fuel ratio are arranged, and it is inputted into input port 36 through A-D converter 38 to which the output signal of these NOX(s) sensor 29 and the air-fuel ratio sensor 30 corresponds.

[0017] Moreover, the load sensor 41 which generates the output voltage proportional to the amount of treading in of an accelerator pedal 40 is connected to an accelerator pedal 40, and the output voltage of the load sensor 41 is inputted into input port 36 through corresponding A-D converter 38. The crank angle sensor 42 generates an output pulse, whenever a crankshaft rotates 30 degrees, and this output pulse is inputted into input port 36. In CPU35, an engine rotational frequency is calculated from the output pulse of this crank angle sensor 42. On the other hand, an output port 37 is connected to an ignition plug 10, a fuel injection valve 11, a step motor 17, and the EGR control valve 27 through the corresponding actuation circuit 39.

[0018] Although mentioned later for details, NOx which will be absorbed if the air-fuel ratio of the exhaust gas which the NOx absorbent of this example absorbs NOx in exhaust gas when the air-fuel ratio of the exhaust gas which flows there is Lean, and flows there becomes rich can be emitted, and reduction clarification of this emitted NOx can be carried out with the hydrocarbon in exhaust gas.

[0019] Moreover, although this is also mentioned later for details, the NOx sensor of this example outputs the output value (output signal) of a different value according to the NOx concentration in exhaust gas. That is, if the NOx concentration in exhaust gas is changed, the output value of the NOx sensor 29 will also be changed. Fundamentally, the NOx sensor malfunction detection approach of this example explained below uses the output characteristics of such a NOx sensor.

[0020] Next, the malfunction detection approach of the NOx sensor of this example is explained. When it is going to detect the abnormalities of the NOx sensor 29, the NOx sensor malfunction detection equipment of this example The NOx concentration in the exhaust gas discharged from a combustion chamber 5 is fluctuated compulsorily. The NOx concentration in the exhaust gas which reaches the NOx sensor 29 by this is fluctuated. When fluctuation of the output value of this NOx

sensor 29 has shifted from predetermined fluctuation as compared with the predetermined fluctuation which probably took fluctuation of the output value (output signal) of the NOx sensor 29 at this time if the NOx sensor 29 was normal, it judges with abnormalities being in the NOx sensor 29.

[0021] In addition, fixed extent which set beforehand and was carried out is sufficient as extent of a gap of fluctuation of the output value of the NOx sensor 29 from the predetermined fluctuation in the case of judging with abnormalities having arisen in the NOx sensor 29, and different extent according to an internal combustion engine's operational status is [ that what is necessary is just to decide that it will be arbitration ] sufficient as it.

[0022] Moreover, width of face which should fluctuate the NOx concentration in the exhaust gas which reaches the NOx sensor 29 when it is going to detect the abnormalities of the NOx sensor 29 is made larger than the width of face of fluctuation of the NOx concentration in the exhaust gas which may happen when having not detected the abnormalities of the NOx sensor 29 (i.e., when the internal combustion engine is made to usually operate).

[0023] An example of the NOx sensor malfunction detection approach of this example is explained with reference to the timing diagram shown in drawing 2. The example shown in drawing 2 is an example which adopted a means to change the rate (for an EGR rate to be called hereafter) to the air of the exhaust gas (EGR gas) made to circulate in a combustion chamber 5 as a means for fluctuating the NOx concentration in the exhaust gas which reaches the NOx sensor 29 at the time of NOx sensor malfunction detection.

[0024] In drawing 2,  $Regr$  is an EGR rate,  $Cnoxin$  is the NOx concentration in the exhaust gas which flows into the NOx absorbent 23, i.e., the concentration in the exhaust gas discharged from a combustion chamber 5,  $Cnoxout$  is the NOx concentration in the exhaust gas which flowed out of the NOx absorbent 23, i.e., the NOx concentration in the exhaust gas which reaches the NOx sensor 29, and  $Inox$  is the output value of the NOx sensor 29.

[0025] In the period when usual control before time of day  $t1$  is performed in the timing diagram shown in drawing 2, i.e., the period which has not detected the abnormalities of the NOx sensor 29. So that the amount (a NOx yield is called hereafter) of NOx generated in a combustion chamber 5 may be maintained by the almost fixed amount smaller than the specified quantity. That is, as the NOx concentration  $Cnoxin$  in the exhaust gas which flows into the NOx absorbent 23 is maintained by almost fixed concentration lower than predetermined concentration, EGR rate  $Regr$  is maintained by the almost fixed rate defined beforehand. since the NOx concentration  $Cnoxout$  in the exhaust gas which flows out of the NOx absorbent 23 at this time turns into concentration about 1 law, the output value  $Inox$  of the NOx sensor 29 outputs the output value of about 1 law.

[0026] On the other hand, it is made to change EGR rate  $Regr$  compulsorily in the timing diagram shown in drawing 2 at the bigger range of fluctuation than the range of fluctuation in the usual control before time of day  $t1$  in the period for detecting the period from time of day  $t1$  to time of day  $t2$ , i.e., the abnormalities of the NOx sensor 29. Thus, if made to change EGR rate  $Regr$  sharply, the NOx concentration  $Cnoxin$  in the exhaust gas which the amount of NOx generated in a combustion chamber 5 is also changed sharply, therefore flows into the NOx absorbent 23 will be changed sharply.

[0027] Although many of NOx in the exhaust gas which flows into the NOx absorbent 23 at this time is absorbed by the NOx absorbent 23, it changes in the range of fluctuation with the bigger NOx concentration  $Cnoxout$  in the exhaust gas which flows out of the NOx absorbent 23 than the range of fluctuation when control is usually performed.

[0028] Now, if the NOx sensor 29 is normal at this time, it will change in the range of fluctuation with the usually bigger output value  $Inox$  of the NOx sensor 29 than the range of fluctuation of the output value of the NOx sensor 29 under control. However, if abnormalities are in the NOx sensor 29, the output value  $Inox$  of the NOx sensor 29 will be changed smaller than the range of fluctuation which can be taken when the NOx sensor 29 is normal, or will hardly be changed.

[0029] That is, if the output value  $Inox$  of the NOx sensor 29 is changed as the chain line A of the timing diagram of drawing 2 showed, when the NOx sensor 29 was normal, and abnormalities are in the NOx sensor 29, as the continuous line B of the timing diagram of drawing 2 showed, it will be changed.

[0030] Then, it judges with there being abnormalities at the NOx sensor 29, when the rate of the

range of fluctuation under malfunction detection to the range of fluctuation under control usually when smaller than that range of fluctuation [ make it change more sharply than that range of fluctuation / EGR rate / under control in this example usually, supervise the range of fluctuation of the output value of the NOx sensor 29 at this time and / range of fluctuation / this ] under control usually is smaller than a fixed rate.

[0031] An example of the flow for performing NOx sensor malfunction detection of this example to drawing 3 was shown. In the flow shown in drawing 3 , it is first distinguished in step 10 whether a car is stationary running. Here, when the vehicle speed is 80 km/h - 90 km/h, it is distinguished that a car is stationary running. Now, in step 10, when a car was not stationary running [ be / it ] and it is distinguished, a routine is ended, but when it is distinguished that a car is stationary running, a routine progresses to step 11.

[0032] At step 11, it is distinguished whether NOx reduction processing which is made to emit NOx from the NOx absorbent 23, and carries out reduction clarification with the hydrocarbon in exhaust gas is performed. In step 11, when NOx reduction processing was performed and it is distinguished, a routine is ended, but when NOx reduction processing was not performed and it is distinguished, a routine progresses to step 12.

[0033] At step 12, it is made to change an EGR rate compulsorily, as the big range of fluctuation is also, and, subsequently difference deltaInox of the maximum of the output value of the NOx sensor 29 at the time of a step 13 odor lever and the minimum value is computed.

[0034] Subsequently, in step 14, it is distinguished whether output difference deltaInox computed in step 13 is smaller than predetermined value deltath. In step 14, when it is distinguished that it is  $\Delta \text{Inox} \geq \Delta \text{Ith}$ , a routine is ended. That is, at this time, it is judged with the NOx sensor 29 being normal. On the other hand, when it is distinguished in step 14 that it is  $\Delta \text{Inox} < \Delta \text{th}$ , it judges with abnormalities being in the NOx sensor 29, and a routine indicates that it progresses to step 15 and abnormalities are in the NOx sensor 29.

[0035] Next, an example other than the example mentioned above is explained. With the NOx sensor malfunction detection equipment of this 2nd example, a means to fluctuate the temperature of EGR gas is adopted as a means to fluctuate the NOx concentration in the exhaust gas which reaches the NOx sensor 29. That is, the amount (NOx yield) of NOx generated in a combustion chamber 5 is changed even if it changes the temperature of EGR gas. So, when it is going to detect the abnormalities of the NOx sensor 29, it is made to change compulsorily in the 2nd example at the range of fluctuation with the usually bigger temperature of EGR gas than the range of fluctuation in control. Thus, if made to change the temperature of EGR gas sharply, the amount (NOx yield) of NOx generated in a combustion chamber 5, the NOx concentration in the exhaust gas which is changed sharply, therefore flows into the NOx absorbent 23, and the NOx concentration in the exhaust gas which is changed sharply, therefore flows out of the NOx absorbent 23 will be changed sharply.

[0036] If the NOx sensor 29 is normal at this time, it will change in the range of fluctuation also with the usually bigger output value of the NOx sensor 29 than the range of fluctuation of the output value of the NOx sensor 29 under control. However, if abnormalities are in the NOx sensor 29, the output value of the NOx sensor 29 will be changed smaller than the range of fluctuation which can be taken when the NOx sensor 29 is normal, or will hardly be changed.

[0037] So, in the 2nd example, set during NOx sensor malfunction detection and the temperature of EGR gas is usually fluctuated more greatly than the range of fluctuation of the temperature of the EGR gas under control. the range of fluctuation of the output value of the NOx sensor 29 at this time being supervised, and, when this range of fluctuation is usually smaller than the range of fluctuation under control. Usually, when the rate of the range of fluctuation under malfunction detection to the range of fluctuation under control is smaller than a fixed rate, it judges with abnormalities being in the NOx sensor 29.

[0038] Moreover, with the NOx sensor malfunction detection equipment of the 3rd example of this invention, a means to fluctuate the timing (for ignition timing to be called hereafter) which lights a fuel by the ignition plug 10 into a combustion chamber 5 as a means to fluctuate the NOx concentration in the exhaust gas which reaches the NOx sensor 29 is adopted. That is, the amount (NOx yield) of NOx generated in a combustion chamber 5 is changed even if it changes ignition

timing. So, when it is going to detect the abnormalities of the NOx sensor 29, it is made to change ignition timing compulsorily in the 3rd example at the bigger range of fluctuation than the range of fluctuation of the ignition timing usually performed during control. Thus, if made to change ignition timing sharply, the amount (NOx yield) of NOx generated in a combustion chamber 5, the NOx concentration in the exhaust gas which is changed sharply, therefore flows into the NOx absorbent 23, and the NOx concentration in the exhaust gas which is changed sharply, therefore flows out of the NOx absorbent 23 will be changed sharply.

[0039] If the NOx sensor 29 is normal at this time, it will change in the range of fluctuation also with the usually bigger output value of the NOx sensor 29 than the range of fluctuation of the output value of the NOx sensor 29 under control. However, if abnormalities are in the NOx sensor 29, the output value of the NOx sensor 29 will be changed smaller than the range of fluctuation which can be taken when the NOx sensor 29 is normal, or will hardly be changed.

[0040] So, in the 3rd example, set during NOx sensor malfunction detection and ignition timing is usually fluctuated more greatly than the range of fluctuation of the ignition timing under control. the range of fluctuation of the output value of the NOx sensor 29 at this time being supervised, and, when this range of fluctuation is usually smaller than the range of fluctuation under control. Usually, when the rate of the range of fluctuation under malfunction detection to the range of fluctuation under control is smaller than a fixed rate, it judges with abnormalities being in the NOx sensor 29.

[0041] By the way, in the example mentioned above, since an EGR rate is fluctuated during NOx sensor malfunction detection, the temperature of EGR gas is fluctuated or ignition timing is fluctuated, the operational status of the internal combustion engine under NOx sensor malfunction detection will shift from the operational status demanded not a little. This is not desirable from a viewpoint of making the output stabilized from the internal combustion engine output.

[0042] Then, even if control for detecting the abnormalities of the NOx sensor 29 is performed, only when the conditions by which extent an internal combustion engine's operational status shifts

[ extent ] from demand operational status is controlled small are filled with the example mentioned above, NOx sensor malfunction detection is performed. Only when fluctuation of the torque which an internal combustion engine outputs will be settled in tolerance even if it performs control for detecting the abnormalities of the NOx sensor 29 if another way of saying is adopted, NOx sensor malfunction detection is performed.

[0043] As conditions by which extent an internal combustion engine's operational status shifts [ extent ] from demand operational status even if it performs control for detecting the abnormalities of the NOx sensor 29 is controlled small For example, it is a time of a steady state having operation of an internal combustion engine, and is a time of a steady state having operation of an internal combustion engine in this way at the time when the torque required of an internal combustion engine is fixed, or when the internal combustion engine is carried in the car, it is a time of the car running with constant speed.

[0044] By the way, as mentioned above, if the air-fuel ratio of the exhaust gas which flows there becomes rich, the NOx absorbent 23 will emit absorbed NOx and will carry out reduction clarification of this emitted NOx with the hydrocarbon in exhaust gas. By the way, there is a limitation in the amount of NOx which can absorb the NOx absorbent 23. Therefore, although the NOx absorbent 23 can absorb most flowing NOx until the total amount of NOx (a total NOx absorbed amount is called hereafter) absorbed by the NOx absorbent 23 exceeds the threshold value (following and NOx absorption limit value) If a total NOx absorbed amount reaches a NOx absorption limit value, the NOx absorbent 23 cannot absorb NOx any longer. Therefore, it flows out of the NOx absorbent 23, without NOx which flowed into the NOx absorbent 23 being absorbed by the NOx absorbent 23, and exhaust air emission gets worse as a result.

[0045] In the example mentioned above, in order to control aggravation of the exhaust air emission by such reason, before a total NOx absorbed amount reaches a NOx absorption limit value, supply the exhaust gas of a rich air-fuel ratio to the NOx absorbent 23, NOx is made to emit from the NOx absorbent 23, and it is made to perform NOx reduction processing for making the NOx absorbent 23 carry out reduction clarification of this NOx made to emit. In the above-mentioned example, aggravation of exhaust air emission is controlled thus.

[0046] In addition, NOX The approach of making rich the air-fuel ratio of the exhaust gas which

flows into an absorbent 23 has various approaches. For example, by making rich the average air-fuel ratio of the gaseous mixture in a combustion chamber 5, the air-fuel ratio of exhaust gas can also be made rich, and the air-fuel ratio of exhaust gas can also be made rich by injecting an additional fuel in the expansion-stroke last stage or an exhaust stroke, or it is NOX. The air-fuel ratio of exhaust gas can also be made rich by injecting an additional fuel in the flueway of the absorbent 23 upstream. the example of this invention -- the basis of the 1st approach, i.e., a rich air-fuel ratio, -- homogeneity -- gaseous mixture -- it is made to make the air-fuel ratio of exhaust gas rich by making it burn.

[0047] By the way, when the amount (total NOx absorbed amount) of NOx which NOx reduction processing is performed and is absorbed by the NOx absorbent 23 approaches zero, you are made for NOx reduction processing to be completed, but if a total NOx absorbed amount approaches zero, ammonia will be generated by the NOx absorbent 23, therefore ammonia will flow out of the NOx absorbent 23.

[0048] And the NOx sensor 29 of this example can also detect ammonia concentration. Therefore, though tend to detect the abnormalities of the NOx sensor 29, and an EGR rate is fluctuated, the temperature of EGR gas is fluctuated or ignition timing is fluctuated, when the exhaust gas of a rich air-fuel ratio is made to flow into the NOx absorbent 23, ammonia might flow out of the NOx absorbent 23, therefore the NOx sensor 29 may have detected not NOx concentration but ammonia concentration. namely, -- even if NOx sensor malfunction detection is performed during NOx reduction processing activation -- precision -- the abnormalities of the NOx sensor 29 are highly undetectable. So, in the above-mentioned example, only when the air-fuel ratio of the exhaust gas which flows into the NOx absorbent 23 is Lean, NOx sensor malfunction detection is performed.

[0049] Moreover, only when the exhaust gas of a rich air-fuel ratio is supplied to the NOx absorbent 23 by burning a fuel in a rich air-fuel ratio in a combustion chamber 5 during NOx reduction processing and the fuel is made to burn in the Lean air-fuel ratio in a combustion chamber 5, NOx sensor malfunction detection is performed.

[0050] As furthermore mentioned above, NOx reduction processing is performed, when the amount (total NOx absorbed amount) of NOx absorbed by the NOx absorbent 23 approaches zero, ammonia is generated by the NOx absorbent 23, and the abnormalities of the NOx sensor 29 can also be detected using ammonia flowing out of the NOx absorbent 23.

[0051] Namely, when it is going to detect the abnormalities of the NOx sensor 29, the exhaust gas of a rich air-fuel ratio is supplied to the NOx absorbent 23. The output value of the NOx sensor 29 when the total NOx absorbed amount absorbed by the NOx absorbent 23 approaches zero is supervised. When having shifted from the fluctuation which was probably taken when the NOx sensor 29 had normal fluctuation of the output value of the NOx sensor 29 at this time, more specifically When smaller than the range of fluctuation which was probably taken when the NOx sensor 29 had the normal range of fluctuation of the output value of the NOx sensor 29 at this time, you may make it judge with abnormalities being in the NOx sensor 29.

[0052] In addition, the fluctuation period of an EGR rate, the fluctuation period of the temperature of EGR gas, or the fluctuation period of ignition timing is made into about 6 times of the response time of a NOx sensor during NOx sensor malfunction detection. Therefore, when the response time of a NOx sensor is about 1 second, the fluctuation period of an EGR rate, the fluctuation period of the temperature of EGR gas, or the fluctuation period of ignition timing is made into about 6 seconds.

[0053] Moreover, when 1 fluctuation period is considered as one fluctuation during NOx sensor malfunction detection, the transaction count of an EGR rate, the transaction count of the temperature of EGR gas, or the fluctuation period of ignition timing is made into at least 3 times or more.

[0054] Next, the structure of the sensor section of the NOx sensor 29 shown in drawing 1 is explained briefly, referring to drawing 4. from oxygen ion conductivity solid electrolyte layers, such as six oxidization zirconias to which the laminating of the sensor section of the NOx sensor 29 was mutually carried out when drawing 4 was referred to, -- becoming -- these six solid electrolyte layers -- the order from the following and a top -- the 1st -- layer L1 and the 2nd -- layer L2 and the 3rd -- layer L3 and the 4th -- layer L4 and the 5th -- layer L5 and 6th layer L6 \*\* -- it calls.

[0055] When drawing 4 is referred to, it is L1 the 1st layer. It is L3 the 3rd layer. In between, it is porosity, or the 1st diffusion limitation member 50 in which pore is formed, and the 2nd diffusion limitation member 51 are arranged, 52 [ room / 1st ] is formed between these diffusion limitation

member 50 and 51, and it is [ 2nd diffusion limitation member 51 and ] L2 the 2nd layer. In between, 53 [ room / 2nd ] is formed. Moreover, it is L3 the 3rd layer. It is L5 the 5th layer. In between, the atmospheric-air room 54 which is open for free passage in the open air is formed. On the other hand, the outer edge surface of the 1st diffusion limitation member 50 touches exhaust gas. Therefore, exhaust gas flows in 1st room 52 through the 1st diffusion limitation member 50, and the inside of 1st room 52 is thus filled with exhaust gas.

[0056] the 1st which faces 52 the 1st room on the other hand -- layer L1 on inner skin, the 1st pump electrode 55 of a cathode side forms -- having -- the 1st -- layer L1 On the peripheral face, the 1st pump electrode 56 of an anode plate side is formed, and an electrical potential difference is impressed according to the 1st pump voltage source 57 between these 1st pump electrode 55 and 56. The oxygen contained in the exhaust gas in 1st room 52 when an electrical potential difference is impressed between the 1st pump electrode 55 and 56 contacts the 1st pump electrode 55 of a cathode side, and serves as oxygen ion, and this oxygen ion is L1 the 1st layer. Inside is turned to the 1st pump electrode 56 of an anode plate side, and it flows. Therefore, the oxygen contained in the exhaust gas in 1st room 52 is L1 the 1st layer. The amount of oxygen which will move in inside, will be pumped out outside and pumped out outside at this time increases, so that the electrical potential difference of the 1st pump voltage source 57 becomes high.

[0057] the 3rd which, on the other hand, faces the atmospheric-air room 54 -- layer L3 The reference electrode 58 is formed on inner skin. By the way, in an oxygen ion conductivity solid electrolyte, if a difference is in an oxygen density in the both sides of a solid electrolyte layer, oxygen ion will move towards a low oxygen density side in the inside of a solid electrolyte layer from a high oxygen density side. in the example shown in drawing 4 , since the oxygen density in the atmospheric-air room 54 is higher than the oxygen density in 1st room 52, the oxygen in the atmospheric-air room 54 contacts a reference electrode 58 -- a charge -- receiving -- oxygen ion -- becoming -- this oxygen ion -- the 3rd -- layer L3 and the 2nd -- layer L2 and the 1st -- layer L1 It moves in inside and a charge is emitted in the 1st pump electrode 55 of a cathode side. Consequently, electrical potential difference V0 shown with the sign 59 between the reference electrode 58 and the 1st pump electrode 55 of a cathode side It generates. This electrical potential difference V0 It is proportional to an oxygen density difference with the inside of the atmospheric-air room 54 and 1st room 52.

[0058] At the example shown in drawing 4 , it is this electrical potential difference V0. Feedback control of the electrical potential difference of the 1st pump voltage source 57 is carried out so that it may be in agreement with the electrical potential difference produced when the oxygen density in 1st room 52 is 1 p.p.m. That is, the oxygen in 1st room 52 is L1 the 1st layer so that the oxygen density in 1st room 52 may serve as 1 p.p.m. It passes, and it is pumped out and the oxygen density in 1st room 52 is maintained by it at 1 p.p.m.

[0059] In addition, the 1st pump electrode 55 of a cathode side is NOX. NOX which receives, and is formed from the alloy with the ingredient Au with low reducibility, for example, gold, and Platinum Pt, therefore is contained in exhaust gas Within 1st room 52, it is hardly returned. Therefore, this NOX It flows in 2nd room 53 through the 2nd diffusion limitation member 51.

[0060] the 1st which faces 53 the 2nd room on the other hand -- layer L1 On inner skin, the 2nd pump electrode 60 of a cathode side is formed, and an electrical potential difference is impressed according to the 2nd pump voltage source 61 between this 2nd pump electrode 60 of a cathode side, and the 1st pump electrode 556 of an anode plate side. The oxygen contained in the exhaust gas in 2nd room 53 when an electrical potential difference is impressed between these pumps electrode 60 and 56 contacts the 2nd pump electrode 60 of a cathode side, and serves as oxygen ion, and this oxygen ion is L1 the 1st layer. Inside is turned to the 1st pump electrode 56 of an anode plate side, and it flows. Therefore, the oxygen contained in the exhaust gas in 2nd room 53 is L1 the 1st layer. The amount of oxygen which will move in inside, will be pumped out outside and pumped out outside at this time increases, so that the electrical potential difference of the 2nd pump voltage source 61 becomes high.

[0061] On the other hand, if a difference is in an oxygen density in the both sides of a solid electrolyte layer in an oxygen ion conductivity solid electrolyte as mentioned above, oxygen ion will move towards a low oxygen density side in the inside of a solid electrolyte layer from a high oxygen density side. in the example shown in drawing 4 , since the oxygen density in the atmospheric-air

room 54 is higher than the oxygen density in 2nd room 53, the oxygen in the atmospheric-air room 54 contacts a reference electrode 58 -- a charge -- receiving -- oxygen ion -- becoming -- this oxygen ion -- the 3rd -- layer L3 and the 2nd -- layer L2 and the 1st -- layer L1 It moves in inside and a charge is emitted in the 2nd pump electrode 60 of a cathode side. Consequently, electrical potential difference V1 shown with the sign 62 between the reference electrode 58 and the 2nd pump electrode 60 of a cathode side It generates. This electrical potential difference V1 It is proportional to an oxygen density difference with the inside of the atmospheric-air room 54 and 2nd room 53.

[0062] At the example shown in drawing 4 , it is this electrical potential difference V1. Feedback control of the electrical potential difference of the 2nd pump voltage source 61 is carried out so that it may be in agreement with the electrical potential difference produced when the oxygen densities in 2nd room 53 are 0.01 p.p.m. That is, the oxygen in 2nd room 53 is L1 the 1st layer so that the oxygen density in 2nd room 53 may serve as 0.01 p.p.m. It passes, and it is pumped out and the oxygen density in 2nd room 53 is maintained by it at 0.01 p.p.m.

[0063] In addition, the 2nd pump electrode 60 of a cathode side is also NOX. NOX which receives, and is formed from the alloy with the ingredient Au with low reducibility, for example, gold, and Platinum Pt, therefore is contained in exhaust gas Even if it contacts the 2nd pump electrode 60 of a cathode side, it is hardly returned.

[0064] the 3rd which faces 53 the 2nd room on the other hand -- layer L3 an inner skin top -- NOX The cathode side pump electrode 63 for detection is formed. This cathode side pump electrode 63 is NOX. It is formed from the ingredient Rh which receives and has strong reducibility, for example, a rhodium, and Platinum Pt. Therefore, NOX in 2nd room 53 and NO which occupies most actually set on the cathode side pump electrode 63, and it is N2. O2 It is decomposed. O2 by which the fixed electrical potential difference 64 is impressed between this cathode side pump electrode 63 and reference electrode 58 as shown in drawing 4 , therefore decomposition generation was carried out on the cathode side pump electrode 63 It becomes oxygen ion and is L3 the 3rd layer. Inside is turned to a reference electrode 58 and it moves. Current I1 shown with the sign 65 proportional to this amount of oxygen ion between the cathode side pump electrode 63 and the reference electrode 58 at this time It flows.

[0065] As mentioned above, within 1st room 52, it is NOX. It is hardly returned and oxygen hardly exists in 2nd room 53. therefore, current I1 NOX contained in exhaust gas it is proportional to concentration -- \*\*\*\*\* -- thus -- current I1 from -- the NOX concentration in exhaust gas can be detected.

[0066] Ammonia NH3 contained in exhaust gas on the other hand It is decomposed by NO and H2 O in 1st room 52 ( $4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$ ), and this decomposed NO flows in 2nd room 53 through the 2nd diffusion limitation member 51. It sets on the cathode side pump electrode 63, and this NO is N2. O2 O2 by which decomposition generation was decomposed and carried out It becomes oxygen ion and is L3 the 3rd layer. Inside is turned to a reference electrode 58 and it moves. this time -- current I1 NH3 contained in exhaust gas concentration -- it is proportional -- thus -- current I1 from -- NH3 in exhaust gas Concentration can be detected.

[0067] Drawing 5 is a current I1. NOX in exhaust gas Concentration and NH3 Relation with concentration is shown. Drawing 5 to current I1 NOX in exhaust gas Concentration and NH3 It turns out that it is proportional to concentration.

[0068] Current I2 which the amount of oxygen pumped out of 52 by the 1st room of the exterior increased on the other hand, so that the oxygen density in exhaust gas was high (i.e., so that the air-fuel ratio was Lean), and was shown with the sign 66 It increases. therefore, this current I2 from -- the air-fuel ratio of exhaust gas is detectable.

[0069] In addition, it is L5 the 5th layer. 6th layer L6 In between, the electric heater 67 for heating the sensor section of the NOx sensor 29 is arranged, and the sensor section of the NOx sensor 29 is heated by this electric heater 67 from 700 degrees C to 800 degrees C.

[0070] Drawing 6 is NOX. If output voltage [ of the air-fuel ratio sensor 30 arranged in the exhaust pipe 25 of absorbent 23 lower stream of a river ] E (V), i.e., a general expression, is used, the output-signal level of an air-fuel ratio detection means is shown. The air-fuel ratio sensor 30 generates the output voltage of 0.9 (V) extent, when the air-fuel ratio of exhaust gas is rich, and when the air-fuel ratio of exhaust gas is Lean, it generates the output voltage of 0.1 (V) extent, so that drawing 6 may

show. That is, the output-signal level which shows that the output-signal level which shows a rich thing in the example shown in drawing 6 is 0.9 (V), and is Lean is 0.1 (V).

[0071] on the other hand, it mentioned above -- as -- current I2 of the NOx sensor 29 from -- the air-fuel ratio of exhaust gas can be detected, therefore the NOx sensor 29 can also be used as an air-fuel ratio detection means. In this case, it is not necessary to form the air-fuel ratio sensor 30.

[0072] Next, the fuel-injection control of an internal combustion engine shown in drawing 1 is explained, referring to drawing 7 (A). In addition, in drawing 7 (A), the axis of ordinate expresses engine load Q/N (inhalation air content Q / engine rotational frequency N), and the axis of abscissa expresses the engine rotational frequency N.

[0073] It sets to drawing 7 (A) and is a continuous line X1. Stratification combustion is performed in a operating range by the side of low loading. That is, as shown in drawing 1 at this time, Fuel F is injected towards the inside of a cavity 12 in the compression stroke last stage from a fuel injection valve 11. This fuel is guided by the inner skin of a cavity 12, and forms gaseous mixture in the circumference of an ignition plug 10, and an ignition plug 10 carries out [ this gaseous mixture ] firing combustion. At this time, the average air-fuel ratio in a combustion chamber 5 serves as Lean.

[0074] on the other hand -- drawing 7 (A) -- setting -- continuous line X1 in the field by the side of a heavy load, a fuel injects from a fuel injection valve 11 in an intake stroke -- having -- this time -- homogeneity -- gaseous mixture -- combustion is performed. in addition, continuous line X1 The chain line X2 between -- the basis of the Lean air-fuel ratio -- homogeneity -- gaseous mixture -- combustion carries out -- having -- the chain line X2 The chain line X3 between -- the basis of theoretical air fuel ratio -- homogeneity -- gaseous mixture -- combustion carries out -- having -- the chain line X3 a heavy load side -- the basis of a rich air-fuel ratio -- homogeneity -- gaseous mixture -- combustion is performed.

[0075] In this invention, as the basic fuel oil consumption TAU required to consider as theoretical air fuel ratio showed the air-fuel ratio to drawing 7 (B), it memorizes in ROM34 beforehand in the form of a map as a function of engine load Q/N and the engine rotational frequency N, and the final fuel oil consumption TAUO (= K-TAU) is computed by carrying out the multiplication of the correction factor K to this basic fuel oil consumption TAU fundamentally. This correction factor K is beforehand memorized in ROM34 in the form of a map as a function of engine load Q/N and the engine rotational frequency N, as shown in drawing 7 (C).

[0076] The value of this correction factor K is the chain line X2 of drawing 7 (A) with which combustion is performed under the Lean air-fuel ratio. The chain line X3 of drawing 7 (A) with which it is smaller than 1.0 in a operating range by the side of low loading with the chain line, and combustion is performed under a rich air-fuel ratio In a operating range by the side of a heavy load, it becomes larger than 1.0. Moreover, this correction factor K is the chain line X2. Chain line X3 In the operating range of a between, it is referred to as 1.0, and at this time, based on the output signal of the air-fuel ratio sensor 28, feedback control of the air-fuel ratio is carried out so that it may become theoretical air fuel ratio.

[0077] Next, the NOx absorbent 23 is explained. NOX An absorbent 23 makes an alumina support and at least one chosen from Potassium K, Sodium Na, Lithium Li, alkali metal like Caesium Cs, Barium Ba, an alkaline earth like Calcium calcium, Lanthanum La, and rare earth like Yttrium Y and noble metals like Platinum Pt are supported on this support. In this case, NOX which arranges the particulate filter which consists of a cordylite in casing 24, and makes an alumina support on this particulate filter An absorbent 23 can also be made to support.

[0078] Even if it is which case, an engine inhalation-of-air path, A combustion chamber 5 and NOX It is this NOX if the ratio of the amount of air to the amount of the fuel (hydrocarbon) supplied in the flueway of the absorbent 23 upstream is called the air-fuel ratio of the inflow exhaust gas to the NOX absorbent 23. An absorbent 23 is NOX when the air-fuel ratio of inflow exhaust gas is Lean. It absorbs. The air-fuel ratio of inflow exhaust gas is theoretical air fuel ratio or NOX absorbed when it became rich. NOX to emit An absorption/emission action is performed.

[0079] This NOX It will be NOX if an absorbent 23 is arranged in an engine flueway. An absorbent 23 is NOX actually. Although an absorption/emission action is performed, there is also a part which is not clear about the detailed mechanism of this absorption/emission action. However, it is thought that this absorption/emission action is performed by the mechanism as shown in drawing 8 . Next, it

becomes the same mechanism even if it uses other noble metals, alkali metal, an alkaline earth, and rare earth, although this mechanism is explained taking the case of the case where Platinum Pt and Barium Ba are made to support, on support.

[0080] In the internal combustion engine which showed drawing 1, combustion is performed for an air-fuel ratio in the state of Lean in the operational status of most with high operating frequency. Thus, when combustion was performed in the state of Lean, as the oxygen density in exhaust gas has a high air-fuel ratio and it showed drawing 8 (A) at this time, it is these oxygen O<sub>2</sub>. It adheres to the front face of Platinum Pt in the form of O<sub>2</sub>- or O<sub>2</sub><sup>-</sup>. On the other hand, NO in inflow exhaust gas reacts with O<sub>2</sub>- or O<sub>2</sub><sup>-</sup> on the front face of Platinum Pt, and is NO<sub>2</sub>. It becomes (2 NO+O<sub>2</sub> ->2NO<sub>2</sub>). Subsequently, generated NO<sub>2</sub> Being absorbed in an absorbent and combining with the barium oxide BaO oxidizing on Platinum Pt, a part is diffused in an absorbent in the form of nitrate ion NO<sub>3</sub><sup>-</sup>, as shown in drawing 8 (A). Thus, NO<sub>x</sub> NO<sub>x</sub> It is absorbed in an absorbent 23. As long as the oxygen density in inflow exhaust gas is high, it is NO<sub>2</sub> in the front face of Platinum Pt. It is generated and is NO<sub>x</sub> of an absorbent. It is NO<sub>2</sub> unless absorptance is saturated. It is absorbed in an absorbent and nitrate ion NO<sub>3</sub><sup>-</sup> is generated.

[0081] On the other hand, if the air-fuel ratio of inflow exhaust gas is made rich, the oxygen density in inflow exhaust gas will fall, consequently it is NO<sub>2</sub> in the front face of Platinum Pt. The amount of generation falls. NO<sub>2</sub> When the amount of generation falls, a reaction goes to hard flow (NO<sub>3</sub><sup>-</sup>->NO<sub>2</sub>), and nitrate ion NO<sub>3</sub><sup>-</sup> in an absorbent is NO<sub>2</sub> thus. It is emitted from an absorbent in a form. this time -- NO<sub>x</sub> NO<sub>x</sub> emitted from the absorbent 23 unburnt [ which is contained in inflow exhaust gas as shown in drawing 8 (B) / a lot of ] -- you react with HC and CO and it is made to return Thus, it is NO<sub>2</sub> on the front face of Platinum Pt. When it stops existing, it is NO<sub>2</sub> from an absorbent to the degree from a degree. It is emitted. Therefore, if the air-fuel ratio of inflow exhaust gas is made rich, it is the NO<sub>x</sub> absorbent 23 to NO<sub>x</sub> to the inside of a short time. It is emitted and, moreover, is this emitted NO<sub>x</sub>. Since it is returned, it is NO<sub>x</sub> in atmospheric air. It is not discharged.

[0082] In addition, it is NO<sub>x</sub> even if it makes the air-fuel ratio of inflow exhaust gas into theoretical air fuel ratio in this case. An absorbent 23 to NO<sub>x</sub> It is emitted. however -- the case where the air-fuel ratio of inflow exhaust gas is made into theoretical air fuel ratio -- NO<sub>x</sub> An absorbent 23 to NO<sub>x</sub> the total absorbed by the NO<sub>x</sub> absorbent 23 since it is not emitted gradually -- NO<sub>x</sub> Time amount long a little to making it emit is required.

[0083] Next, NO<sub>x</sub> An absorbent 23 to NO<sub>x</sub> It is NO<sub>x</sub> that it should emit. The amount and NO<sub>x</sub> of a reducing agent when making rich the air-fuel ratio of the exhaust gas which flows into an absorbent 23 Ammonia NH<sub>3</sub> in the exhaust gas which flows out of an absorbent 23 into a lower stream of a river Relation with concentration is explained. The amount of a reducing agent is explained first. NO<sub>x</sub> A superfluous fuel is NO<sub>x</sub> to fuel quantity required to make into theoretical air fuel ratio the air-fuel ratio of the exhaust gas which flows into an absorbent 23. Since it is used for bleedoff and reduction, the amount of this superfluous fuel is NO<sub>x</sub>. It is in agreement with the amount of the reducing agent used for bleedoff and reduction. This is NO<sub>x</sub>. An absorbent 23 to NO<sub>x</sub> It is NO<sub>x</sub>, when it should emit and the air-fuel ratio of the gaseous mixture in a combustion chamber 5 is made rich, or when an additional fuel is injected in the expansion-stroke last stage or an exhaust stroke. It is applied even when an additional fuel is injected in the flueway of the absorbent 23 upstream.

[0084] Next, the concentration of ammonia is explained. When an air-fuel ratio is Lean (i.e., when it is an oxidizing atmosphere), it is ammonia NH<sub>3</sub>. It hardly generates. However, when an air-fuel ratio becomes rich (i.e., if it becomes reducing atmosphere), it is nitrogen N<sub>2</sub> in inhalation air or exhaust gas. It is returned by Hydrocarbon HC in an oxidation catalyst or a three way component catalyst 20, and is ammonia NH<sub>3</sub>. It is generated. However, if an air-fuel ratio becomes rich, NO<sub>x</sub> will not flow out. An absorbent 23 to NO<sub>x</sub> Ammonia NH<sub>3</sub> emitted and generated This NO<sub>x</sub> Since it is used in order to return, it is NO<sub>x</sub>. An absorbent 23 to NO<sub>x</sub> The reducing agent supplied to accuracy while being emitted is NO<sub>x</sub>. It is NO<sub>x</sub> while being used for bleedoff and reduction. It is ammonia NH<sub>3</sub> to the lower stream of a river from an absorbent 23. On the other hand, NO<sub>x</sub> NO<sub>x</sub> from an absorbent 23 If the air-fuel ratio is made rich even after bleedoff is completed It is NO<sub>x</sub> if it says to accuracy more. An absorbent 23 to NO<sub>x</sub> In order to emit and return, when the reducing agent of the surplus which is not used is supplied, it is ammonia NH<sub>3</sub>. It is already NO<sub>x</sub>. Being consumed for reduction

is lost. At this time, it is NOX thus. It is ammonia NH<sub>3</sub> to the lower stream of a river from an absorbent 23. It will flow out.

[0085] This is NOX. It is generated even when the oxidation catalyst or the three way component catalyst 20 is not formed in the upstream of an absorbent 23. Namely, NOX It is NOX if an air-fuel ratio becomes rich, since the absorbent 23 is also equipped with the catalyst of the platinum Pt which has a reduction function. It sets to an absorbent 23 and is ammonia NH<sub>3</sub>. It may be generated. However, it is ammonia NH<sub>3</sub> even if. Even if generated, it is this ammonia NH<sub>3</sub>. NOX NOX emitted from the absorbent 23 Since it is used in order to return, it is NOX. To the lower stream of a river from an absorbent 23, it is ammonia NH<sub>3</sub>. It does not flow out. However, NOX An absorbent 23 to NOX It is NOX as it mentioned above, when the reducing agent of the surplus which is not used was supplied, in order to emit and return. It is ammonia NH<sub>3</sub> to the lower stream of a river from an absorbent 23. It will flow out.

[0086] Thus, NOX It is NOX when the air-fuel ratio of the exhaust gas which flows into an absorbent 23 is made rich. An absorbent 23 to NOX In order to emit and return, when the reducing agent of the surplus which is not used is supplied, the reducing agent of this surplus is ammonia NH<sub>3</sub>. It is NOX in a form. The amount of ammonia which flows into a lower stream of a river, and flows out of an absorbent 23 at this time is proportional to the amount of an excessive reducing agent. Therefore, the amount of ammonia which flows out at this time will show the excessive amount of reducing agents. This amount of ammonia is detected by the NOx sensor 29 which can detect ammonia concentration. In this case, it is thought that the integrated value of this ammonia concentration expresses the excessive amount of reducing agents, therefore it can be said that the integrated value of ammonia concentration is the central value showing the excessive amount of reducing agents. Moreover, it is also possible that the maximum of this ammonia concentration expresses the excessive amount of reducing agents, therefore the maximum of ammonia concentration can be said to be being the central value showing the excessive amount of reducing agents.

[0087]

[Effect of the Invention] Since a NOx sensor outputs the output value of a different value according to the NOx concentration in exhaust gas If the NOx concentration in exhaust gas is fluctuated compulsorily, the output value of a NOx sensor will also be changed. If the NOx sensor is normal here, since it should change that the output value of a NOx sensor is also at a certain predetermined gestalt at this time If it has shifted from the fluctuation which can be taken when a NOx sensor has normal fluctuation of the output value of the NOx sensor at this time, abnormalities have arisen in the NOx sensor.

[0088] Moreover, since a NOx sensor outputs the output value of a different value according to the ammonia concentration in exhaust gas If the amount of NOx which supplies the exhaust gas of a rich air-fuel ratio to a NOx absorbent, and is absorbed by the NOx absorbent is brought close to zero Ammonia flows out of a NOx absorbent, therefore the output value of a NOx sensor is also changed. If the NOx sensor is normal here, since it should change that the output value of a NOx sensor is also at a certain predetermined gestalt at this time If it has shifted from the fluctuation which can be taken when a NOx sensor has normal fluctuation of the output value of the NOx sensor at this time, abnormalities have arisen in the NOx sensor.

[0089] Therefore, according to this invention, the abnormalities of a NOx sensor are detectable.

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[Translation done.]

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**DESCRIPTION OF DRAWINGS****[Brief Description of the Drawings]**

**[Drawing 1]** It is drawing showing the internal combustion engine having the NOx sensor malfunction detection equipment of this invention.

**[Drawing 2]** It is a timing diagram for explaining an example of the NOx sensor malfunction detection equipment of this invention.

**[Drawing 3]** It is a flow chart for performing NOx sensor malfunction detection of this example.

**[Drawing 4]** It is drawing for explaining the structure of a NOx sensor.

**[Drawing 5]** It is drawing showing the relation between NOx concentration and ammonia concentration, and the output current value of a NOx sensor.

**[Drawing 6]** It is drawing showing the output characteristics of an air-fuel ratio sensor.

**[Drawing 7]** It is drawing for explaining operation of an internal combustion engine.

**[Drawing 8]** It is drawing for explaining an operation of a NOx absorbent.

**[Description of Notations]**

1 -- Engine body

23 -- NOx absorbent

29 -- NOx sensor

**[Translation done.]**

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## \* NOTICES \*

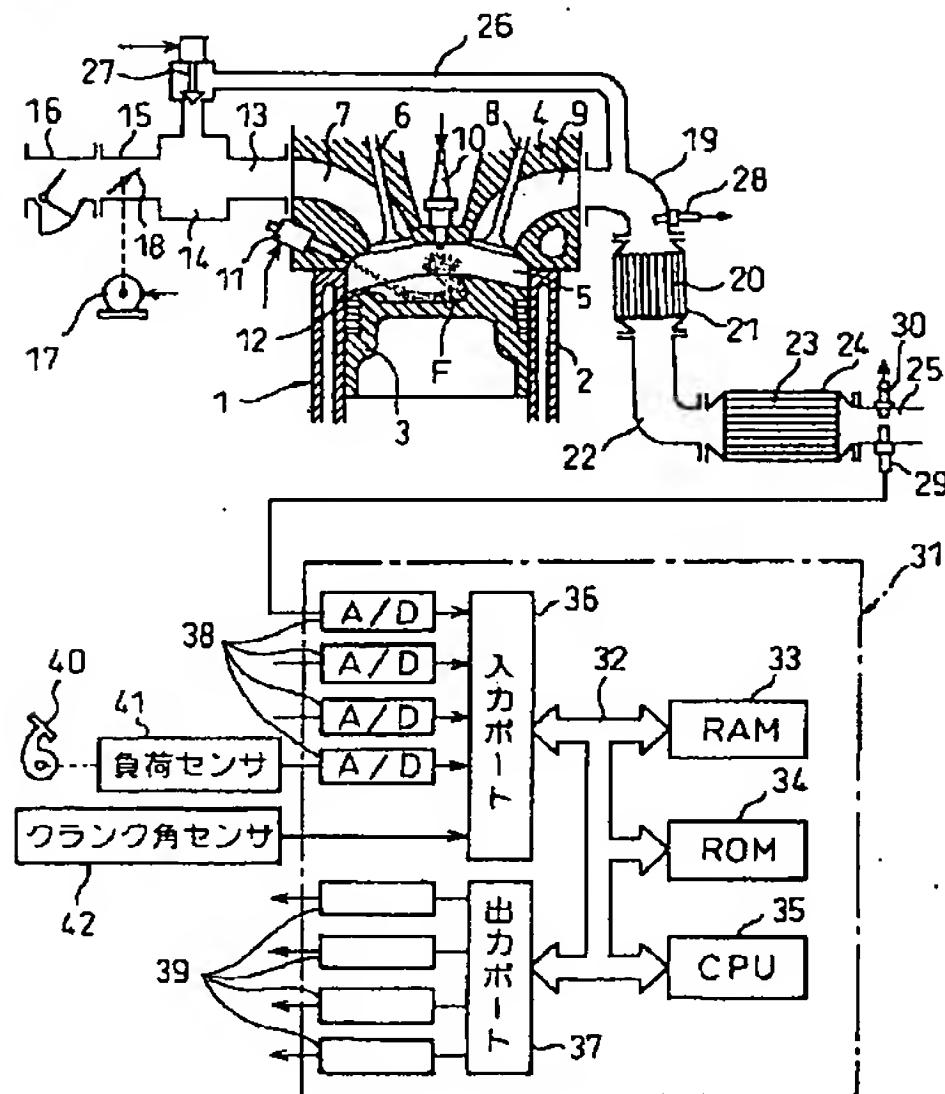
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## DRAWINGS

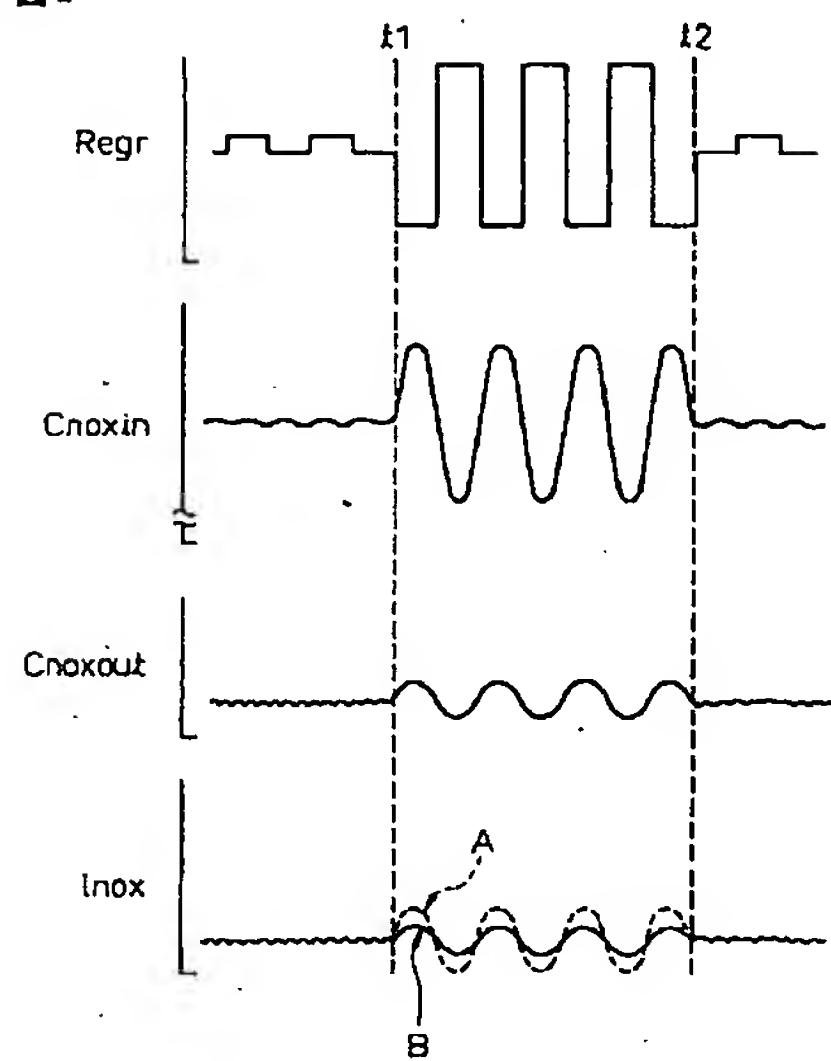
## [Drawing 1]

図1

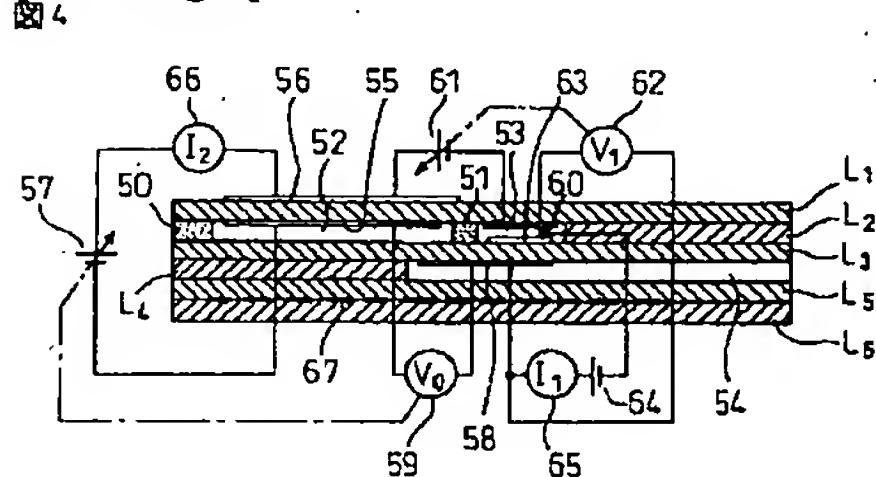


## [Drawing 2]

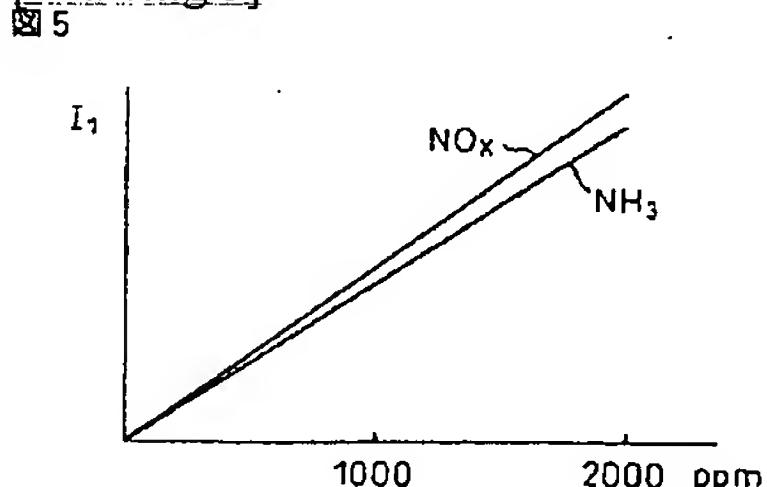
図2



[Drawing 4]

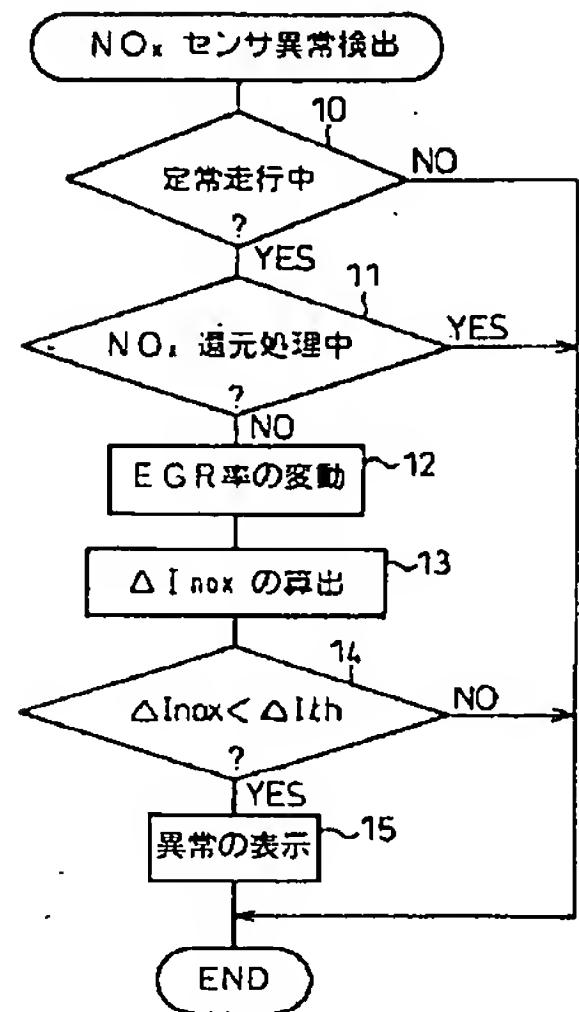


[Drawing 5]



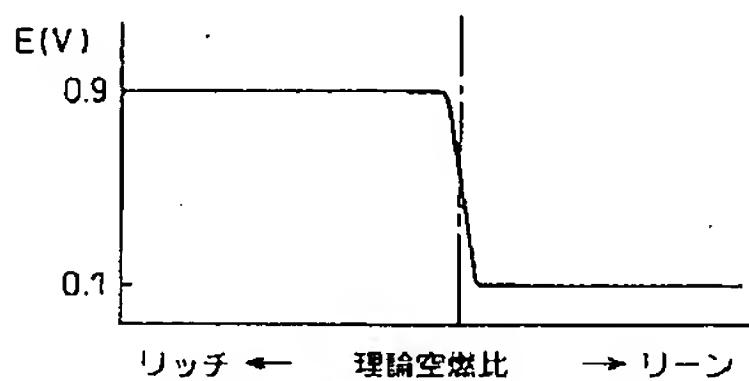
[Drawing 3]

図 3



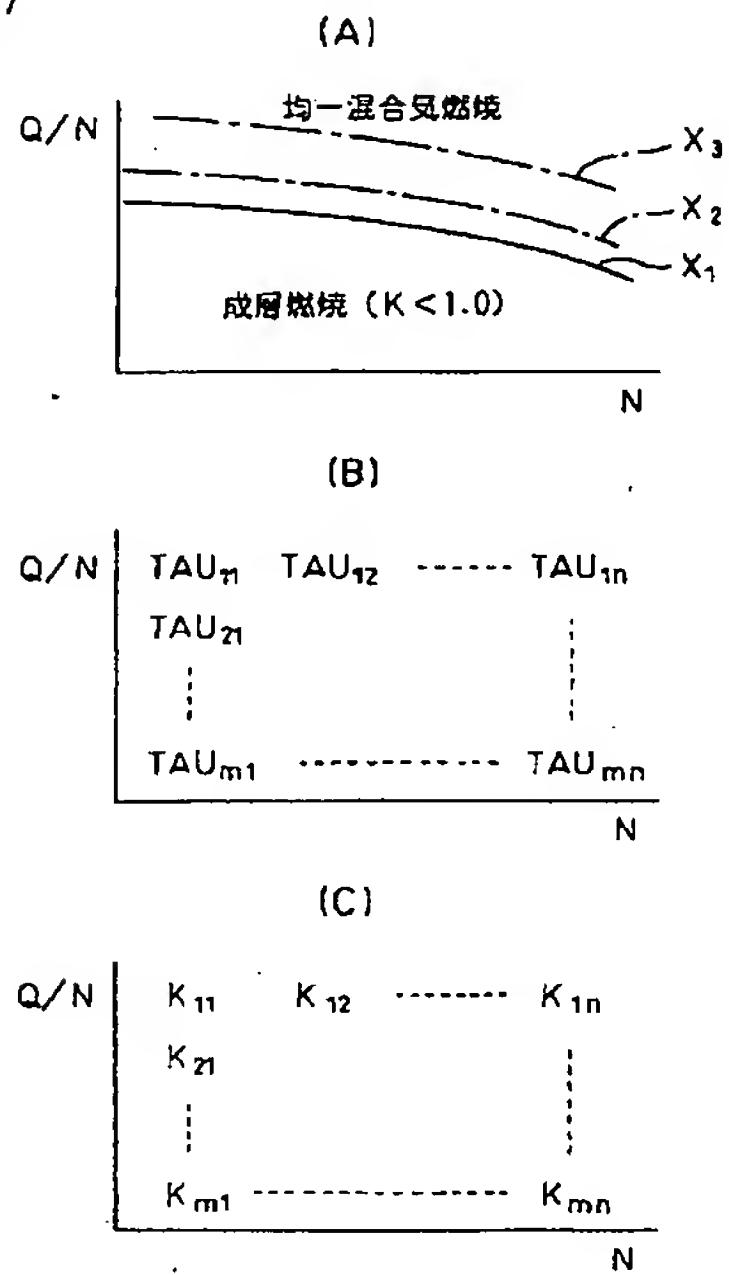
[Drawing 6]

図6



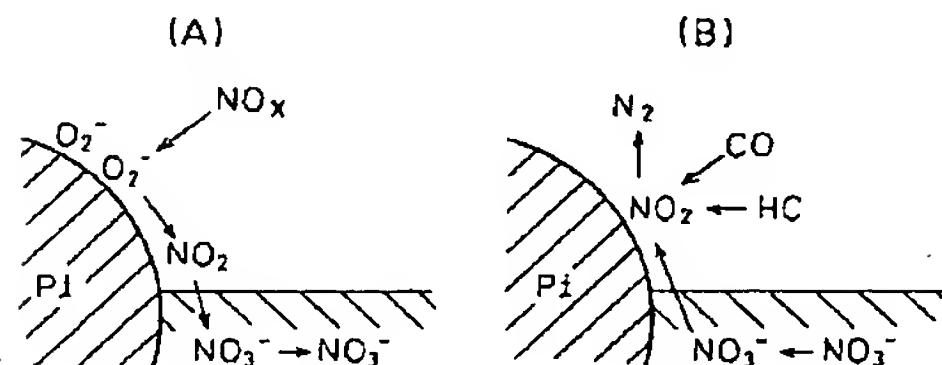
[Drawing 7]

图 7



[Drawing 8]

图 8



[Translation done.]

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